CRASPEDACUSTA SOWERBYI IN SOUTH AUSTRALIA, WITH SOME NOTES ON ITS HABITS

By I. M. Thomas *

[Read October 12 1950]

SUMMARY

1. The occurrence of *Craspedacusta sowerbyi* Lankester in South Australia is noted and some comments made on its distribution throughout the world.
2. The organisms have been observed to feed on a variety of small Crustacea and also on small mosquito larvae. An increase in rate of pulsation is indicated in the presence of Daphnids but the relation of this to feeding is not proven.
3. Medusae show no response to incident light.
4. Medusae show a marked contraction of the velum at low temperatures and are incapable of swimming movements at temperatures below about 13°C.

The genus of freshwater medusae, *Craspedacusta*, is now known to be widely distributed throughout the world. It was first described from specimens taken in the *Victoria regia* tanks in Regent's Park, London, in 1880 by Lankester (1880). It has since been recorded from other parts of England, Europe, North America, Eastern Asia and now an occurrence has been recorded from Australia (Thomas, 1950).

Several species have been described but the validity of some of them is now in doubt. *C.* (*Limnocodium*) *sowerbyi* was established by Lankester from material in Regent's Park, while *C. ryderi* which has been found in some eighteen of the States of North America is now, according to Boulenger and Flower (1928), believed to be identical with it. *C. kawaii* was described from material in the Yangtse River in China by Oka (1907), but it is likely that this (Tang, Yang and Fang (1936)) is only a variety of *C. sowerbyi*. *C. germanica* was described by Persch (1933), mainly from the hydroid stage, but this again seems to be synonymous with *C. sowerbyi* (Boulenger and Flower 1928). *C. iseana* described from material found in a well in the province of Ise in Japan by Oka (1922) does differ in sufficient detail, *e.g.*, smaller total number of tentacles, absence of ring canal, position of the lithocysts at the bases of the tentacles and the isolated arrangement of the nematocysts, to justify its separation.

It seems that the other three species, viz., *C. sowerbyi*, *C. kawaii*, and *C. germanica* may be resolved into the single species *C. sowerbyi*. If this is the case, its occurrence on four of the world's five continents is remarkable. Furthermore, the localities in which it has been found in various parts of the world calls for comment. Of some twenty-nine occurrences in the United States between 1932 and 1938 (Schmitt (1938)), nineteen were in artificial waters such as garden ponds, tanks, aquaria, gravel and clay pits and reservoirs. More recently, Dexter, Surrarrer and Davis (1949) have recorded the medusa from the States of Ohio and Pennsylvania. Some eighteen records are mentioned of which only six are from natural expanses of water, one being a slow flowing stream. In Great Britain and on the Continent, all its occurrences have been in artificial bodies of water (*e.g.*, Tattersall (1933) and

* Department of Zoology, University of Adelaide.

van Someren (1933), though Totton (1929) believes that it is "highly probable that *Craspedacusta* occurs in a wild state in British river systems." There is no direct evidence of this as yet however. In Eastern Asia, apart from *C. kawaii*, which is widespread in the Yangtse and its tributaries, all its appearances have been in similar locations. The single Australian record is from an excavated reservoir. (Thomas 1950).

The predominances of occurrences in artificial waters may have two possible explanations. It may be that such localities are more frequently and more closely observed so that the short-lived medusae would be more likely to be noted when they appear, or it may be that artificial ponds and the like are more frequently stocked with vegetation from other sources thus introducing the hydroid form in mud containing frustules. In at least one case, importation can be attributed to this cause. Amemiya (1930) noted the sudden appearance of medusae in his laboratory aquarium in Tokyo not long after he had introduced into his tanks some water plants imported from San Francisco. In most cases, however, the medusa appears suddenly in fairly large numbers in waters where there is no record of the recent introduction of new plants or animals. The hydroid stage is capable of reproducing asexually by transverse fission, frustule formation, and bud formation (Persch, 1933) and can presumably remain viable in these forms for long periods, medusae being produced only when conditions are favourable. Once the latter have appeared, most records show that their production is repeated annually at about the same season for some years.

There is little direct evidence of the ability of the hydroid or its frustules to resist desiccation. Their formation has been described in detail by Persch (1933) but he does not mention any form of encapsulation. Payne (1924), however, states that the hydroid bears a covering which is "more than a slimy mucous secretion" and figures it as having a layered structure. Mud and detritus particles adhere to this. Frustules may be able to develop a similar protection. Dissemination of the organism must then be in mud carried on the roots of transplanted vegetation or possibly on the feet of water birds.

The natural centres of occurrence of *Craspedacusta* seem to be North America and the Yangtse, and from these sources it has been conveyed by natural or artificial means to other parts of the world. It is impossible to say at present with any degree of certainty from which of these regions the forms found at Thorndon Park Reservoir near Adelaide emanated. There is no evidence of either plants or animals having been deliberately introduced since the opening of the reservoir ninety years ago though some English perch have become established there, probably having come from entering streams or from other reservoirs which now feed into Thorndon Park. The reservoir has now no significant natural inflow but it is maintained as a storage tank being filled by gravity from other reservoirs higher in the hills behind it. Investigations have failed to disclose the presence of medusae in these even though there is a weekly routine examination by officers of the Engineering and Water Supply Department.

The first specimens were seen on March 7th, 1950, and several visits in succeeding months showed their presence in varying numbers up until June, since when none have been seen. The numbers of specimens taken on different dates in this period are indicated in Fig. 1. The points marked cannot be regarded as being more than a rough indication of the number of organisms present as weather conditions influence considerably the ease with which they can be seen in the water. An overcast sky and a moderate breeze ruffling the surface make their observation more difficult. All visits were made in the early afternoon. Specimens were caught with a hand net from a boat. Approximately an hour was spent on the lake on each occasion. There appears to be a marked peak in abundance at about the end of April and the beginning of May, the surface water at this time being between 16° and 17°C. All medusae taken were female. Their gonads ripened at about this peak period of abundance. Medusae caught varied in size between 1cm. and 1·9cm., the larger specimens being taken at the period of peak abundance.

Medusae were always found most abundantly in about the centre of the lake, where the depth is thirty feet or more. On no occasions were they seen towards the sides in less than ten or twelve feet of water. Even when fairly strong breezes caused appreciable surface currents, still no specimens were

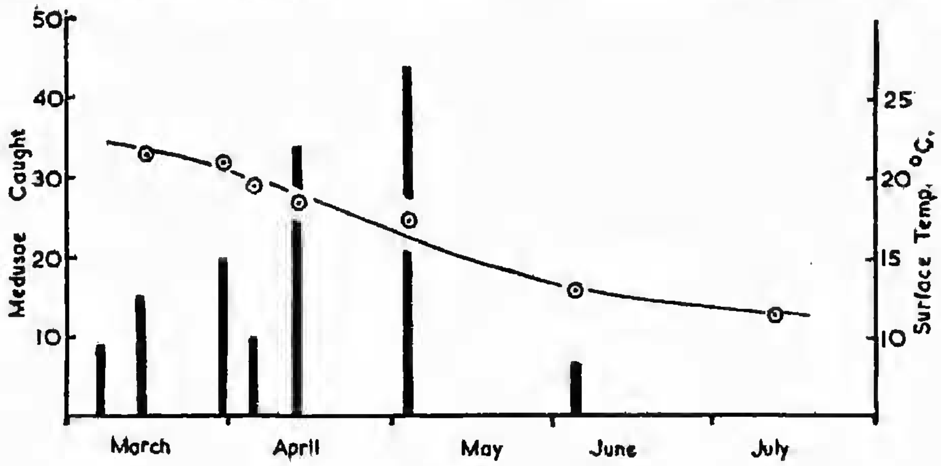

Fig. 1
Heavy vertical lines indicate the abundance of *Craspedacusta* at different dates. Points show surface water temperatures on those dates.

seen near the leeward bank. Generally they occurred in loose patches of about half a dozen individuals in several square yards, this being separated by ten or fifteen yards from another similar patch. Their numbers were thus considerably less than have been reported from several locations in North America where, for example, Cheatum (1934) records that in a small artificial pond near Dallas, Texas, a single scoop with a pint jar yielded as many as sixteen specimens. Sufficient were brought back from Thorndon Park to the laboratory from time to time to allow of some detailed observations on their habits and to carry out some experiments.

FEEDING

Specimens in the laboratory have been observed to feed on Daphnids, Cyprids, small Amphipods and first and second instar mosquito larvae. Daphnids were the commonest food and indeed the only type of food observed in the gastrovascular cavity of those in the reservoir. If some of these were placed in a finger bowl with a medusa, many of them were killed, presumably by coming into contact with the nematocysts of the tentacles. Death was by no means instantaneous because many escaped after being entangled with a tentacle. Further, food organisms could be seen to be still motile after entering the gastrovascular cavity. The mouth is four-cornered and that part of the gut enclosed in the manubrium is transversely ridged in such a way that when the manubrium lengthens and shortens with each pulsation of the bell, the food is forced further in. Once in the more spacious gastrovascular cavity, the particle can float around more freely in the fluid it contains and it may even penetrate not only into the base of a radial canal but also into the lumen of a gonadial sac.

The tentacles were not observed to play an active part in the passing of food to the manubrium but by unilateral contractions of the velum and a simultaneous flexing of the manubrium in that direction, the mouth could be brought close to the tentacles. No passage of food in this way was ever observed however.

To test the activity of the animals in the presence and absence of suitable food, the following experiment was performed. Four medusae of about equal size were placed in finger bowls each with 200ml. of water. Their temperatures were maintained at 18°C. Rates of pulsation were noted at intervals over a period of half an hour. Then to each of the first two bowls were added 10ml. of water at the same temperature and to each of the second two, the same quantity containing ten living Daphnids. Rates of pulsation were again noted in the succeeding half hour. The results are summarized in Table I. There is a mean difference of 9·1 pulsations per minute with added Daphnids and 0·8 in the controls. This indicates that the presence of Daphnids does stimulate the medusae to greater activity, but further experiments would be necessary to prove the matter conclusively.

Table I

Averaged Rates of Pulsation, each taken from ten readings, of Medusae in the Absence and Presence of Living Daphnids.

Medusa No.	1	2	3	4
Control Period	85·0	86·8	82·4	84·8
Water only added	84·4	85·8	—	—
Daphnids added	—	—	93·3	92·1
Differences	0·6	1·0	10·9	7·3

It has been observed frequently that when a medusa strikes against a solid object such as floating vegetation, or the bottom or sides of a jar, the rate of pulsation increases. Swimming Daphnids may offer a similar stimulus to more rapid pulsation, though whether this possible increase is of any significance in feeding has not been determined by the experiment described nor by replicates of it as on no occasion were Daphnids taken into the mouth though many were killed by contact with the tentacles. The increase in rate of pulsation when a medusa comes in contact with a solid object as, for example, submerged vegetation, was observed and commented upon by Milne (1938), who says that this increase in activity frequently served to push the object to one side so that the organism could force its way past. The present writer has frequently observed the same phenomenon. Once the obstruction was passed, pulsation rate fell to a more normal level.

REACTION OF LIGHT

Milne (1938) reports, as a result of observations on *Craspedacusta* taken at Crystal Lake, near Lynchburg, Virginia, that they have no apparent reaction to incident light. Shadle and Minthorn (1939) on the other hand say that when they found the medusae in a large pond in a gravel pit near Attica, N.Y., they were more frequent in the shadow of a pier. Cheatum (1934) reports finding the medusae most abundantly under lily-pads and in the "ooze" at the bottom of a shallow pond near Dallas. He states, "Wading amongst the lily-pads stirred up the "ooze" on the bottom and in areas where medusae had not hitherto been visible, such riling of the water caused them to appear in thousands." Tang, Yang and Fang (1936), contrary to these findings, report on a positive response to sunlight and electric light but found no response to moonlight.

To check these findings, some medusae were placed in a long glass tube about one and a half inches in diameter, filled with water and arranged horizontally so that light could impinge on the organisms from either or both ends. The experiment was of course carried out in an otherwise dark room. The medusae, though quite active during the experiment, showed no reaction at all to the direction of the light. Similarly when the tube was arranged vertically, there was no apparent response. The use of red, yellow, green and blue filters showed them to be equally unresponsive to any particular range of the spectrum. The experiment was repeated with medusae which had been kept in complete darkness for five hours. After this treatment they were slightly less active but still evinced no response.

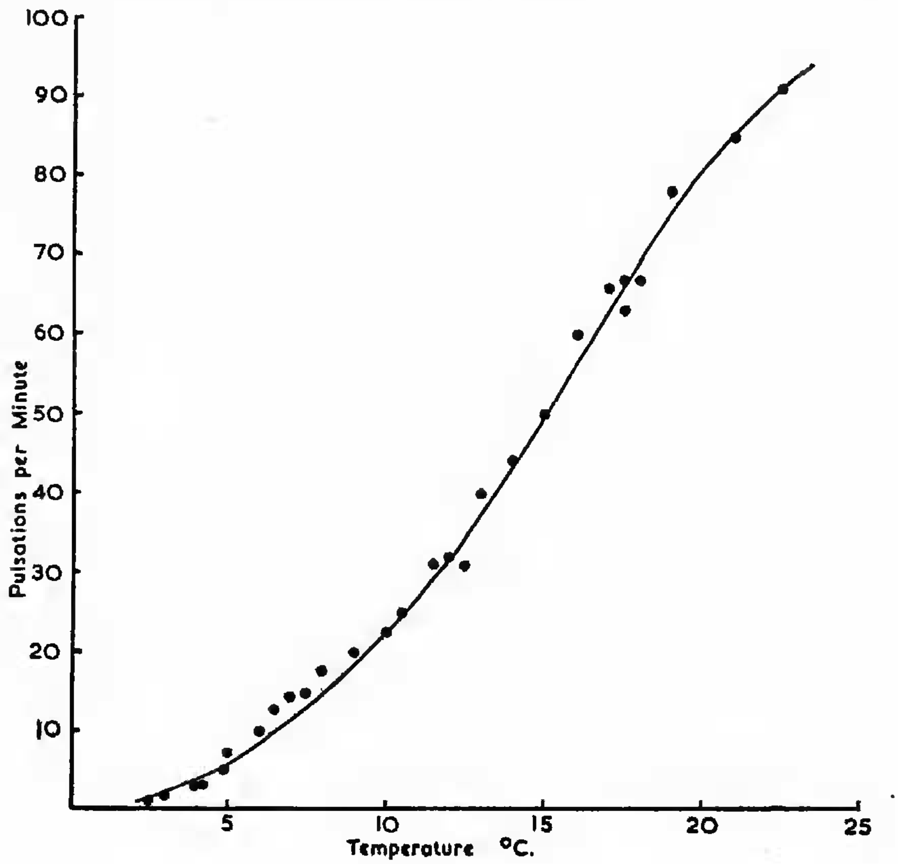

Fig. 2
Influence of temperature on the rate of pulsation in *Craspedacusta.*

REACTION TO TEMPERATURE CHANGES

To test the responses of a medusa to lowered environmental temperatures a specimen was placed in a finger bowl of water and then placed in a larger basin containing water to which chipped ice could be added. The temperature was reduced slowly after the organism had become acclimatised for several hours at 22·5°C. The results are shown in Fig. II. It has already been noted that the medusae increase their rate of pulsation when they strike against a solid object. Points in the figure indicate, for the higher temperatures, rates of pulsations in free floating specimens. As the temperature fell, contraction of the velum became more strongly marked until at below about 14·5°C. the animal ceased to swim and sank to the bottom, where it continued slower and more feeble movements as the temperature fell still lower. Below 5° C. the animal was almost spherical, only a small round aperture remaining in the velum. The manubrium was completely retracted within the sub-umbrellar cavity. Slight pulsations were maintained at a very slow rate down to 2·5°C.

The temperature was allowed to rise gradually after about fifteen minutes at this level and as it did so, pulsations became more frequent and stronger. At 10°C. the velum was reasonably relaxed but it was not until between 14° and 14·5°C. had been reached that normal swimming movements were recommenced. It is interesting to note that the medusae disappeared from the surface waters of Thorndon Park Reservoir when the surface water temperature fell below 13°C. (see Fig. 1). If any remained in the reservoir at that date they were presumably at or near the bottom. The difference in temperatures of cessation of normal swimming in the reservoir and under experimental conditions, can be attributed to acclimatisation of the former to lower temperatures.

The upper limit of temperature tolerance has not been determined here but Milne (loc. cit.), gives it as between 25° and 30°C. for his specimens. Specimens investigated by Tang, Yang and Fang (1936), in Amoy, showed a temperature preference of 28°C., which was approximately the normal ambient temperature.

They say that, in a long tube, the medusae moved from cooler and warmer regions and congregated at this temperature. When cooled in beakers from 28°C. movement became abnormal at 31° to 35°C. and ceased at 36°. At 28°C. the rate of pulsation was about 120 per minute. The higher temperatures tolerated by these specimens can be accounted for by their acclimatisation to a high environmental temperature.

REFERENCES

AMEMIYA, I. 1930 "Freshwater Medusa found in the Tank of my Laboratory." (In Japanese.) Abstract in Jap. Journ. Zool., **3**, 3

BOULENGER, C. L., and FLOWER, W. K. 1928 "The Regent's Park Medusa, *C. sowerbyi* and its identity with *C.* (*Microhydra*) *ryderi*." Proc. Zool. Soc., London, 1,005-1,015

CHEATUM, E. P. 1934 "A New Distributional Record for the Medusa *Craspedacusta*." Science, N.S., **80**, 528

DEXTER, R. W., SURRARRER, T. C., and DAVIS, C. W. 1949 "Some Recent Records of the Freshwater Jellyfish *Craspedacusta sowerbyi* from Ohio and Pennsylvania." Ohio Journ. Sci., **49**, 235-241

LANKESTER, R. RAY 1880 "On *Limnocodium* (*Craspedacustes*) *sowerbyi*. A new Trachomedusa inhabiting Freshwater." Q.J.M.S., **20**, 351-371

MILNE, L. J. 1938 "Some aspects of the Behaviour of the Freshwater Jellyfish, *Craspedacusta* sp." Amer. Nat., **72**, 464-472

OKA, A. 1907 "Limnocodium im Yangtsekiang." Zool. Anz., **32**, 669-671

OKA, A. 1922 "Eine neues Limnocodium aus Japan." Zool. Anz., **54**, 198-200

PAYNE, F. 1924 "Study of the Freshwater Medusa *Craspedacusta ryderi*." Journ. Morph., **38**, 387-430

PERSCH, H. 1933 "Untersuchungen über *Microhydra germanica* Roch." Zeitschr. Wiss. Zool., **144**, 163-210

SCHMITT, W. L. 1938 "Freshwater Jellyfish Records since 1932." Amer. Nat., **73**, 83-89

SHADLE, A. R., and MINTHORN, K. 1939 "*Craspedacusta* again in Western New York," Amer. Micros. Soc., **58**, 254-255

TANG, D. S., YANG, F. F., and FANG, T. C. 1936 "On the Occurrence of Freshwater Medusae in Amoy." Lingnan Science Journal, **15**, 445-452

TATTERSALL, W. M. 1933 "Occurrence of *Craspedacusta sowerbyi* Lankester in Monmouthshire." Nature, **132**, 570

THOMAS, I. M. 1950 "*Craspedacusta sowerbyi* in Australia." Nature, **166**, 312-313

TOTTON, A. K. 1929 "Freshwater Medusae in England." Nature, **123**, 912

VAN SOMERN, V. D. 1933 "A Scottish occurrence of *Craspedacusta sowerbyi* Lankester." Nature, **132**, 315

ADDENDUM

Since this paper went to press, a reprint of an article by P. L. Kramp ("Freshwater Medusae in China", Proc. Zool. Soc. Lond., **120**, 165-184, 1949) has been received. In this, the distribution of *C. sowerbyi* in China is discussed and details given of a further species, *C. sinensis*, first described by Gaw and Kung (Sci. Rep. Nat. Wuhan Univ., pp. 1-11, 1939). This co-exists with *C. sowerbyi* in pools near Kaitung, Szechuen, though it is much less abundant. Kramp supports the contention of Sowerby (1941) that the Upper and Middle Yangtse River Valley is the original home of the genus, whence it has been transported probably by human agency to other parts of the world, possibly in mud on the roots of the water hyacinth (*Eichhornia*) or similar water plants.

Eichhornia has been introduced into Australia, and bade fair to become a serious pest in the River Murray and other places until vigorous measures were taken to control it. It has not, however, been reported from any of the Adelaide reservoirs though it is still fairly common as a garden plant on the Adelaide Plains. The Adelaide Hills region, which includes the drainage area of the reservoirs, does not offer a suitable habitat for the growth of *Eichhornia,* so it does not seem likely that this plant is the medium through which the coelenterate was introduced into Australia.

Up to the present time (June 1951) no further specimens of the medusae have been reported from the Adelaide reservoirs.